A Low Cost Simulation System to Demonstrate Pilot Induced Oscillation Phenomenon

First Annual Performance Report
(According to NASA Handbook 5800.1C paragraph 1260.402)

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LIST OF CONTENTS

Performance and the Chronology of Progress

The project aimed at developing a low cost simulation facility to demonstrate the pilot induced oscillation phenomenon. As a first major step of the project, installation of flight simulation with graphics on a computer workstation was needed at Tuskegee University Campus.

From June 1, 1994, a selection process was initiated to find a suitable computer configuration for the project. Communication took place between the principal investigator (PI), the consultant, and the NASA technical officer. The following computer configuration was purchased by the Tuskegee University on the grant for the present project.

> SGI INDIGO2 XZ Graphics, 100/50 MHz, 1 GB system disk, 32 MB memory and 32 MB memory upgrade, internal 4mm digital audio SCSI tape drive, internal dual speed CD ROM SCSI drive, IRIS development option, C++ compiler, and FORTRAN 77 compiler.

The computer is located in the Flight Vehicle Design Laboratory of the Aerospace Science Engineering Department at Tuskegee University. With the help from Office of Computer Services at Tuskegee University, ethernet connection is provided in the laboratory and the computer is connected to ethernet. The computer is also provided with an uninterrupted power supply.

The installation of F-15 Flight Simulation software is scheduled to take place in the second reporting period, when the NASA-Dryden team of two experts will visit Tuskegee University Campus. In the mean time, the PI and the student workers directed their attention to preparation for conduct of the simulation study and research.

The consultant helped the PI by identifying some reference books which have been acquired. With his co-researchers, the consultant had developed a set of Flight Dynamics Simulation Programs in C++. The programs involve the use of vector, matrix, and quarternion. He provided his programs to the PI for study and possible trial runs on the INDIGO2. One of the student workers studied the programs with reference to the equations of airplane dynamics available from a textbook (ref. 1). He also practiced on the flight simulation demos of SGI that are available on INDIGO2. The other student worker devised three sets of lab guidelines to operate a PC version of the Microsoft Flight Simulator. Three students of an elementary aerospace course used those lab guidelines to fly an airplane on the Microsoft Flight Simulator.

One of the recent studies on pilot induced oscillation has been conducted by Hess and Kalteis (ref. 2). They have provided a six step technique to model longitudinal pilot induced oscillations.

The present project will obtain experimental data on the pilot induced oscillations when a pilot will operate a simulated flight on a computer workstation. The study of technique recommended by Hess and Kalteis (ref. 2) would also be considered.

Personnel

Dennis Ezell and Donna Childs have been associated with the project as undergraduate student workers. The Principal Investigator obtains consulting help from Dr. Amnon Katz of the University of Alabama. Mr. Larry Schilling, the NASA Technical Officer on the project provides appropriate managerial and technical help needed from NASA.

References

1. Nelson, R.C. Flight Stability and Automatic Control. McGraw Hill, 1989.

2. Hess, R.A. and Kalteis, R.M. "Techniques for Predicting Longitudinal Pilot Induced Oscillations," *Journal of Guidance, Control, and Dynamics,* v14, n1, Jan-Feb. 1991, pages 198-204.

Abstracts of References

1. Nelson, 1989: This is a textbook on the topics of airplane equations of motion, static stability, and dynamic stability. It covers longitudinal, directional, and roll stability.

2. Hess and Kalteis, 1991: A technique for predicting the susceptibility of an aircraft to longitudinal pilot induced oscillations is proposed. The technique uses the optimum control mode (OCM) of the human pilot formulated for pitch attitude command tracking tasks. The criterion is based on the pilot/vehicle open loop transfer function as predicted by the OCM.